D R A F T - B O R R A D O R

US – Mexico Water Workshop

Application of Innovative Technologies to Water Issues on the Border
September 25 – 27, 2002

Summary of Results

Objective

The objective of the workshop was to identify promising topics for bi-national technical collaborations related to water issues on the US – Mexico border. Topics will be prioritized based on severity of needs and on maturity of potential technology solutions. Workshop discussion summaries will be used as the basis for a Concepts Report detailing the potential joint projects.

Format

The five topical sessions each consisted of two speakers and discussion held after the presentations. Presentations addressed issues such as resource environment, political environment, technology options, and summary bottom line of key needs. Jessica Glicken-Turney facilitated discussion sessions for brainstorming and prioritizing topics for collaboration.

Session 1: Salt Water Intrusion

Focus: Included synopsis of the Ensenada and Sonora coastal aquifer situation and technologies for water resource management.

The Mexican perspective was presented by Dr. Luis Walter Daessle Heuser, (UABC) and MSc. Carlos Gutiérrez Ojeda (IMTA), and the US perspective by Dr. Erik K. Webb (SNL).

Highlights of Presentation by Luis Walter Daessle

The research has focused on the Maneadero aquifer located near Ensenada, BC. Information on salt water intrusion into said aquifer was presented and it is assumed that this is due primarily to over exploitation.

- The research group consists of Environmental and Marine Geochemists doing major ion and metal geochemistry.
- Historic data on recharge of aquifers were presented along with some of the group's recent data.
- Study area: Baja California is divided into 7 hydrologic regions, one is Ensenada.
- Since 1988, depletion of aquifer (recharge minus discharge) is proceeding at a rate of -132 Mm^3/yr. A good estimate of capacity of aquifer is not available, however, it is

needed in order to know when conditions will get to the point that intrusion will no longer seasonally retreat. Very serious problem because there is no other source of freshwater in the region.
- The group is analyzing groundwater TDS and Na^+ to determine saltwater intrusion. The data show that saltwater intrusion going up quickly near coast.

Highlights of Presentation by Carlos Gutiérrez Ojeda

CNA data was presented on the aquifers of Region II, which corresponds to the state of Sonora. Emphasis was made on the aquifers that are overdrawn (15 of 45) and particularly the Costa de Hermosillo aquifer, where extraction is 420 Mm^3/year and recharge only 350 Mm^3/yr. Some data on salt water intrusion was also presented for this aquifer. Finally, it was pointed out that water use efficiencies are very low in the region: from 40% to 60% for drinking water and 50% to 58% for agricultural irrigation.

- State of Sonora located in NW region of Mexico, >200K sq km total surface area.
- Total population approximately 2 million people (2% of national).
- Irrigation districts very close to coastal areas.
- Very high variations in rainfall historically, but see severe drought ongoing since approximately 1994.
- Irrigation and activities mostly based on groundwater, very little surface water.
- Agricultural irrigation makes up 95% of total water use in the state and groundwater is utilized in 42% of agricultural applications.
- From 47 aquifers declared by CNA, 15 are overexploited, 19 balanced, 13 underexploited. Total –453 Mm^3/yr overexploited. Problem is mostly in the northern aquifers. Find >4000 mg/L solids in water extracted from an overexploited aquifer; this is not useable.
- Principal problems: contamination of aquifers by wastewater in San Luis Rio Colorado, saltwater intrusion, lack of monitoring stations.
- Monitoring stations: very few wells, have very little hydrologic data.
- Programs have been started to reduce extraction to values close to the recharge. Have prohibited extraction in some overexploited aquifers. Historical data show extraction peaked in 1986 and has gradually declined since then as a result of efforts to reduce, including switch to drip irrigation, crops that require less water, and smaller irrigated areas. However, the curve has started to turn up again.

Summary of problems

- Inefficient use of water, especially irrigation and public water supply systems
- Overexploitation of 15 of the 47 aquifers
- Saltwater intrusion
- Water contamination from untreated wastewater (Only 10% of total wastewater is treated).
- Flooding and droughts
- Population is increasing, as well as associated demands for water and agriculture
- Very few monitoring programs, stations, lack of hydrogeologic infrastructure

- **Solutions:** Two most important are to stabilize most overexploited aquifers and improve infrastructure for measurements.

Erik Webb

The presentation demonstrated ample experience in relation to management of salt water intrusion. Coincided with Dr. Polioptro Martínez's message that a holistic vision is needed to address these type of issues. On the other hand, it was mentioned that the USGS has a nation-wide groundwater monitoring network, with the data located at a web-site (http://ca.water.usgs.gov./water_quality/). It was briefly commented that some models are available on the market, such as: SHARP, SUTRA, MOC, HST3D, Well Master, etc.

With respect to salt water intrusion, one needs to control the pumping location and time, maintain a balance between extractions and recharge, plan long-term demands and have proper land use in order not to affect the amount and quality of the aquifers.

- Freshwater resources along border: surface water and groundwater. The two are intricately connected. Drought condition is across border and well into both countries.
- Concern for saline water intrusion is the freshwater/saltwater border moving inward. Inland, the problem is upward movement of saline water from below.
- Holistic view is critical: surface and groundwater are connected, need to look at them as watersheds. Those watersheds have no knowledge of political boundaries. Have lack of groundwater data (much better understanding of surface water). Need full system models. Most difficult: must find mechanisms by which we jointly manage the resource.
- Need characterization: objective is ability to have a strong understanding (conceptual model) that explains what is happening. Geometry, quantitiy, quality, time history of saline intrusion, etc. Techniques include classic (like wells) to advanced geophysical tools.
- Need greater exchange of data/information across border, must be accessible to all.
- Need modeling to integrate data and conceptual models in order to explain to others and do predictive analysis. Requires exchange of codes, cross-training, and integration of concepts across border.
- Once have all that, need optimized management. Involves things like timing and location of pumping, balance extraction/recharge rates, long-term demand, land-use that affects water quantity and quality.
- Last, must share management information in an accessible and understandable manner.
- Professional and Management meetings provide one avenue for information exchange. Also internet work groups, such as provided by USGS.
- Expanding technology options: microsensors for chemical constituents, stage and sediment transport sensors, integrated watershed modeling.
- **Suggestions:** Overarching is US/Mexico collaboration to understand joint resources along border. Includes components of:

- Sharing of existing data
- Develop joint databases
- Share existing models and cross-train
- Joint testing/application of emerging technology

Discussion: What are the key needs?

- Aquifer characterization (watershed level; aquifers know no political boundaries) Total aquifer management is the overriding theme: how much water can we take out and preserve quantity and quality, what is cost, etc.
- Have to know exactly how much water must have in aquifer in order to prevent saltwater intrusion.
- Barriers to stop water discharge to the ocean
- Monitoring (in Mexico for less parameters than in US) – do not have complete or accurate data such as needed to characterize different zones of an aquifer. This is problem across all of Mexico, not just the border and coastal regions.
- Modeling for use in prediction and/or management
- Data exchange and management
- Efficiency of supply systems
- Expertise transfer (collaborative funding, need a formal facilitative mechanism)
- Brackish water unusable (make usable by means of desalination?)
- Wastewater treatment: must have awareness of safety and health issues, even if there are none, in using treated wastewater to irrigate. There are export issues. Perception of people in California (US) is that they want "pure" water, no increased risk of cancer, etc. What people are willing to accept in Mexico may be different. An additional issue in using treated wastewater is pharmaceuticals and their degradation (different under oxidative vs. reducing environments).
- Government in Mexico doesn't have means to improve treatment levels, such as tertiary wastewater treatment. Don't even have a decent primary treatment in some places in Baja California.
- If researchers are not interacting with policy-makers, then they won't be successful. Interact in crisis situations, but must fund research to address issues that will enable crisis avoidance.
- Very difficult to find real costs of any type of water treatment. Need a database that is kept current on cost of treatment implementation. Must have access to that type of data in order to make rational decisions.
- Not only cost, but who's going to pay for it.
- Local water supply management must tie use to supply to policy.
- Reuse of treated wastewater would be compromise to export of produce to US
- Awareness (what level of health risk would the population be willing to accept?)
- Assymetry of resources across two sides: expertise, means, funds on US side but not on Mexican side. Recognize assymetry in political jurisdiction (Mexico federal, U.S. individual States), too.
- Be careful on use of words that can be interpreted differently.

- Decision makers look at bottom line. Compare what water costs now to the costs of pumping and importing, and the decision makers will see that it is worthwhile to wisely manage our resources.

Discussion: What are the solutions?

- Expertise transfer mechanism? (collaborative funding)
- Wastewater treatment need
- Cost of technology implementation
- Technical Assistance for Loan Applications
- Develop a Binational Technical Center like the US/Russia program that provides resources for international technical collaboration. To make this possible, the BECC and NADB would be asked to participate
- Total aquifer management (economy: use – supply – policy; managing local supply; need to know amount of water required to prevent saltwater intrusion)
- Aquifer characterization vs management
- Managing asymmetry of resources (US – Mexico; State vs Federal; International Technical Center; NADBank – BECC)
- NADBank is a funding resource, 100 km to north and 300 km to south. Charter broadened to more than wastewater. BECC also provides binational funding. $80M specifically earmarked for effiiency of irrigation, proposals being accepted through January. BECC/NADBank are merging.
- U.S. agencies require a lot of paperwork to apply for the money, need technical assistance to those who want to apply.
- Formal working relation amongst groups (like USGS & INEGI) on both sides of border to exchange basic information in an integrated way.
- Joint projects (e.g. Conacyt-NSF)
- Inform policy-makers of issues & needs

Session 2: Desalination

Focus: Included current approaches and new technologies for cost-effective desalination.

The Mexican perspective was presented by Drs. Rafael Enrique Cabanillas López (Univ. of Sonora) and Felipe Correa Díaz (UABC); and the US perspective was presented by Dr. Thomas E. Hinkebein (SNL).

Rafael Cabanillas

The presentation focused on experience in desalination in the state of Sonora. Several projects were described, including Puerto Lobos, where a solar distillation unit was installed (supported by Programa Solidaridad) and using technology developed by Mr. McCraken. The distillation unit was never completely finished, there were also some design errors, it never received proper maintenance, and afterwards was destroyed by a huricane. This technology can produce 528 gpd (2,000 Lpd) of good quality water with little or no expenditure of fuel and few operational problems.

Solar distillation

Experience in three locations in Sonora where they have desalination activities. Solar has been used because of local conditions: dryness, solar intensity, extensive coastal area.

- Rocky Point was a joint research project of U. Sonora and U. Arizona. Used solar heat and a diesel engine. Not much information available.
- A second project was built in the 1970's. Also not much information. Capacity was about 1300 liters per day. A hurricane destroyed it all.
- Puerto Lobos (fisheries, tourist area). Installation was to provide electricity, water, ice for 300 inhabitants. Solar desalination design by Mr. McCracken, 480 sq m, 20 linear collectors, seawater provided through a well. Installation produced 2000 L/day. Started in 1992 with several participants (U Sonora, IMADES, Sandia Labs, NMSU, more).
  Good production of water with surface area available. Adequate to supply community. Excellent quality; gastrointestinal illnesses immediately relieved. Community gathered together to do some minimal maintenance on the facility. Monitoring equipment was provided by Sandia and NMSU to do follow-up work. Interesting observation is that the production continues after sunset. Unit production almost 6 L/m^2 at start, but has decreased to less than half that over time. Problems decreasing production: plant never finished or officially handed over to users; no operating manual; some design problems related to cleaning (algae growth, salt incrustations); no technical assistance; lack of maintenance/repair; animals and dust (breaking glass, coyote trying to get at water).

Conclusions: Technology is very good, applicable for small communities. But needs improvements in technology to minimize problems.

- It is recommended that this technology be improved with support possibly from SNL.
- It has both advantages and disadvantages.
- It appears to be an excellent alternative for small communities.
- The design of the units needs to be improved.

Felipe Correa

The presentation focused on future needs for desalination in the northeast of Mexico. A very interesting graph showed decreasing cost of desalination during the past fifty years, including Reverse Osmosis, Distillation (used in the Arabian Penninsula) and Brackish Water Treatment technologies.

- Desalination in NW Mexico (Sonora and part of Baja California).

- NW Mexico has important economic activity and growth in population. The economic model is reflected also in the water use model, and has increased demand. Very low rainfall. Example: 8 Bm^3/yr consumption in area that cannot sustain it. Require desalination. Another example: adequate water but not where it is needed, and quantities not reliable. Aquifers are overdrawn.
- Must take social, political and economic factors into account in order to get into desalination. Example is a desal plant for the city of Hermosillo that was cancelled due to political reasons.
- Chart of cost comparison of desal technologies shows any type of desalination is more expensive than conventional sources. Note that conventional sources are usually subsidized, so cost is not real. The cost of desal has been going down in recent years due to improvements in technology. Cost of fuel is also an influence.
- Example of discharge of brackish water reject that is not apparently causing any adverse impacts, cannot see any effect on ocean. Monterrey area. Depends on goodwill and regulations. Inject brackish water into coastal aquifers, distribution is very efficient. However, there are limitations as to the amount, 30,000 m^3/day is limit.
- In Spain, have surface disposal and let it run into the sea in an area where they have high mixing. Impacts are visual and erosion.
- When you don't want to have impacts on beach, need to send out in an underwater outfall, same model as for wastewater outfalls. However, not applicable to brackish water because of density differences (wastewater compared to brackish), but commonly used nonetheless.

Tom Hinkebein

Desalination research performed by SNL, in collaboration with USBR, was presented conceptually. Different types of technologies have been considered for application in both coastal and non-coastal communities, as well as rural towns and large cities. Graphs were also shown of the decrease in desalination costs. The processes to be followed in research work were indicated to consist of: technical evaluation of the project, laboratory modeling, pilot plant program, and finally a demonstration unit. The talk ended with a description of the research center that will be established in the Tularosa Basin.

- Effort to determine what future technology areas will be important to deliver safe, sustainable, affordable, adequate water. Focus on what technology can do to improve desalination and improve reuse.
- First looked at "What are the needs?" Then identify where technology development is addressing those needs and where there are gaps.
- Came up with five very important needs:
  - Develop new sources – because of quantity or quality
  - Reduce costs
  - Protect quality
  - Reclaim waters
  - Develop concentrate disposal

- Costs: technology builds on technology, can extrapolate costs for evolutionary improvements. RO was invented 30 years ago and is only now getting to the point of being reasonably economic. Electric power is a huge portion of cost (44%), so reducing power consumption is a good R&D goal.
- When you start thinking about revolutionary technologies, you have to start by screening for feasibility (is a law of thermodynamics being violated?).
- Tularosa Basin National Desalination Research Facility is being designed, planning to begin construction in fiscal year 2003. Will be located in Alamagordo, New Mexico.

Lorenzo Arriaga

The talk focused on several experiences, such as: treatment of the Salton Sea, desalination plant in Phoenix, development of a brackish water desalination plant for the El Paso/Cd. Juárez region.

Collaboration to address primary needs of inland desalination: what do you do with concentrate/brine? Neighborhood of 3000 mg/L. Many times, this is still a useable resource.

Discussion: Key needs

- Multiple technology paths: It will be very hard to solve all desalination needs with only one technology.
- Concentrate disposal or reuse (also known as discharge, brine, etc.)
- Explore alternate uses of concentrate that may not require as low a salt concentration.
- Maintenance of solar distillation installation (especially for use in remote communities)
- Reducing costs: construction materials vs design issues, operation, energy (fuel source) vs emissions
- Energy: not only a cost issue, also an availability issue, as well as pollution
- Legislation to establish discharge parameters
- Standalone (distributed) systems are a couple of orders of magnitude more expensive than those on grid. Should explore implementing centralized systems even for very small communities. Issue of tradeoffs for centralized vs. distributed solutions.
- Need to look at why desal plants built 30 years ago were abandoned.
- Lesson learned is to do a local needs assessment and get the community invested in the project. For the abandoned plants, somebody from the government came and put the plant there, never asked if they wanted it (should consider local needs. Built it, left it, and the community found it cheaper to bring in the water than to power and maintain the plant.
- Reliable demand forecasting for 10, 20, etc. years in the future.

Session 3: Agriculture

Focus: Included protected agriculture, food protection, advanced irrigation, brackish-water resistant crops

The Mexican perspective was presented by Dr. Héctor Manuel León Gallegos (Chihuahua State Governement) and MSc. Efrén Peña Peña (IMTA), and the US perspective was presented by Darryl Drayer (SNL).

Darryl Drayer

Presentation focused on iniciative on agricultural security and food safety. Among other issues, it was pointed out that a tool has been developed at SNL to estimate biological security risks due to ranching/livestock. Also, greenhouse polymer filter experiences were discussed.

In conclusion, a proposal was made for US – Mexico collaboration, which could have Mexico build the greenhouses and conduct monitoring activities, and SNL could install the filters and perform information analysis.

- Sandia is just starting to work on issues in agricultural security and food safety.
- Dairies: example of 3000-head dairy in Mesquite, New Mexico. This is a relatively small dairy, most are getting up to 10,000. Lots of issues with wastewater.
- Border issues: Assuring that products crossing border are free of pathogens. Last year ran 300,000 head of cattle through Santa Teresa Border Station. Zero this year because of outbreak of TB in Texas. Huge economic consequences of disease.
- Decontamination formulation, a non-toxic and non-corrosive aqueous foam, could have numerous applications in food safety. Speculate use to decontaminate trucks that animals are carried in.
- Rapid Syndrome Validation Project was designed for physicians to input data on people coming into emergency rooms in order to rapidly identify disease outbreak. Was tested in Albuquerque and is now being deployed in Las Cruces. Looking to adapt for veterinarian use.
- Protected agriculture: experimentation with films to block out types of light not needed by plants (infrared and ultraviolet), thus reducing cooling costs. Data show higher yields with these photoselective films. Reduced water use in evaporative coolers by 80%.
- Evaporation suppression: apply a monolayer film onto a body of water to prevent or slow evaporation. Tests were done on 8' pools. Likely applications could be for small bodies of water (e.g. stock ponds), not so likely for large reservoirs. Need to study long-term effects on aquatic systems before these can be deployed.
- NMSU aquaculture facility is breeding silvery minnow, as endangered species.
- Development and demonstration of protected agriculture is a potential joint project:
  - Mexico would provide the greenhouses, growing and monitoring.
  - Sandia would provide films for greenhouses and analysis

Hector Leon

The Government of the State of Chihuahua has implemented a greenhouse program, having built 150 units throughout the state during the past 2 years. The following technical information was provided.

- The greenhouses include: black screens, watering timing mechanism, water spraying devices, etc.
- Plant growth of 1_ incher/day is obtained.
- Cost of greenhouse with a surface area of 144 m^2 and 1972 trays is $ 132,000 pesos.
- Savings in water is substantial.
- Corn and wheat produce the best results.

- Rainfall has been very low, no rain at all last 20 days.
- Started one year ago, already have 150 greenhouses.
- Objective of program is to feed 120 head of cattle everyday.
- Greenhouse size is 8 by 18 meters (144 sq m). From the day that germination of corn or wheat begins, it takes 10 days to be able to feed the animals.
- Very simple greenhouses. Sensors and computers to start irrigation when gets light (or dry?). Each day, they plant 172 trays. Takes 10 days to fill greenhouse and by day 10, the first set of trays are ready, so the cycle becomes continuous.
- No heaters or ventilators. Corn in spring and summer, wheat in fall and winter.
- Hydroponic because no soil, just add some nutrients.
- If remote area, use solar power to pump the water.
- The big issue of water: 1 ton of fodder in the greenhouse takes 1000 – 1200 litres of water. Traditional agricultural approach for 1 ton of alfalfa takes 1.2 – 1.4 million litres!

Efren Pena

The talk focused on the development of agricultural irrigation technology that uses water more efficiently and its recent application in the Delicias, Coahuila, irrigation district.

The Mexican Water Technology Institute developed the following material:

- Design Manual for small irrigation areas.
- Flow Measurement Manual.
- Planning Manual to technify irrigation.
- Computer Program RIPRES, for pressure irrigation, which allows the design of irrigation sections of high uniformity.
- Computer Program to design furrow irrigation areas.
- Computer Program for surface irrigation.
- Computer Program for leveling plots.
- Computer Program for irrigation forecasting.

The application of these technologies in the State of Colima has resulted water savings of 40% in lemon orchards, 39% in banana plantations, and 67% in produce farms.

- The National Water Commission and the Water Technology Institute have been working on an irrigation strategy involving evaluation of irrigation, prioritization, improved technology, demonstration and training.
- Studies were performed in irrigation areas. Have areas where have to pump water from deep wells. Evaluated the pumping systems and conveyance.
- The farmers didn't know how much water to apply for irrigation, what types of fertilizer, how much fertilizer. This has resulted in overuse of water and fertilizers and produced contamination of aquifers. In surface irrigation, another problem has been leveling of land. Don't have proper design for irrigation of plots.
- Training manuals were developed to help in transfer of technology.
- Irrigation approach includes numerous factors: field design, irrigation design, leveling, etc. Most important factor is to establish how much water and when it should be applied. Very simple process, analyzes how much water was used in preceding seven days, and considers average of same amount to be needed in next seven days. As plant grows, correct for size using the seven day model.
- What can we do for the future?
    - If we use regulatory standards for the type of materials and design, we can improve the uniformity of application.
    - We can design hydraulically with great uniformity.
    - Government is trying to introduce standard for use of manuals for irrigation in real-time and fertilization.
    - If use these tools, can prevent pollution of the aquifers.
    - Implement modern systems using drip irrigation, greenhouses, conductivity and pH to improve productivity of fertilizer.
    - But concentrating on productivity doesn't prevent pollution. Requires laboratories to analyze water and soil, education to raise users' awareness of problems of pollution.

Summary of topics mentioned during presentations:

- Water security and sustainability
- Biosecurity Risk Assessment Tool (BRAT)
- Traceability (farm to fork)
- Pathogen detection
- Decontamination formulation
- Rapid Syndrome Validation Project for Animals (RSVP-A)
- Protected agriculture
- Evaporation suppression
- Protected agriculture (films filter IR & UV; photoselective films)
- Monolayer surface film (evaporation suppression; practical for small areas only)

Discussion: Key Needs

- Contamination from agricultural uses, from livestock, fertilizers, etc.
- Evaporation suppression
- "Protected agriculture," greenhouses
- Monitoring and data collection for humidity, temperature control
- Need to convey methods of use along with the technology so as to use properly (technology transfer)
- Conveyance issue – unlined ditches, PVC pipes, cement pipes – lots of water losses
- Connection between fertilization/productivity/pollution
- Same problems in pressurized irrigation on both sides of border. For example, U. Arizona was promoting drip irrigation that used too much water.
- Irrigation efficiencies in several categories
- Challenge traditional approaches, e.g. look to unconventional crops
- Innovative technologies for water utilization.

Session 4: Wastewater Treatment Issues and Technologies

Focus: Included anaerobic technology development and application in small communities with wastewater treatment needs that are low-cost and easy to operate and maintain.

The Mexican perspective was presented by Dr. Adalberto Noyola (UNAM) and the US perspective by MBA Gray Lowery (SNL).

Adalberto Noyola

The focuse of this presentation was on biotechnologies for wastewater treatment, with emphasis on research performed at the Engineering Institute (II) of the UNAM. The Institute has obtained patents for an anaerobic reactor and a micro treatment unit. Seven of these systems have been built for municipalities, 3 domestic applications (micro units), 5 in breweries, 4 in food industries, and one in a chemical plant.

The fields that the Institute is currently following include: research, package solutions, technology transfer, training, and publications. Decentralized solutions are also being looked at in order to attain sustainable management of wastewater through small scale treatment "*in situ*".

- Biotechnology for pollution prevention and environmental remediation is natural, non-toxic residues, low energy requirements, but limited use, slow.
- UASB: Sludge reactor. Have a number of municipal, domestic brewery, food, and chemical industry applications in Mexico, Chile, and Argentina.
- Their research is focused on biological wastewater treatment technologies that have low operations costs and do not require skilled workers. Have a main objective to transfer technology and to disseminate work through education, publications and presentations.
- Decentralized treatment in the neighborhood requires: 1) non-conventional sewer systems that are shallower and have small collecting areas; and 2) adapted wastewater

treatment processes that are compact, efficient and reliable, low O&M costs, low production of treatment residues, and low environmental impact.
- They have a six step process that is built upon a basic process of screen sand grit removal and anaerobic reactor. Additional steps depending on the effluent quality needed.
- Micro-reactor is 1 meter tall, uses 60 watts power, very quiet. Sludge removal is main maintenance item. Cost is now high because reactor is not commercial yet, around $3000. Have sold three of them so far. Would like a businessman to produce. Have U.S. and Canadian patents.
- Political, social supported decisions are needed in order to face the sanitation problem with new approaches. Otherwise, the goals will never be attained.

Gray Lowrey

A brief description was provided of several BECC certified projects regarding wastewater treatment, as well as industrial pretreatment efforts undertaken on the border. It was pointed out that SNL is involved in a project for small communities solutions and also provides industrial pretreatment technical assistance.

- Survey of various wastewater projects in Border Environmental Cooperation Commission (BECC/COCEF) 2001 report. $220+ Million on 8 projects.
- There are regulatory differences because after Peso devaluated in1994, there were funding issues and agencies in US and Mexico diverged in their regulations, for example, fecal coliform and chlorine residue.
- Industrial wastewater: only 15% of plants have pretreatment. Opportunity for projects because NADBank is very interested in loaning money for these projects (low-interest funding).
- Small community solutions:
  - Contaminant threat assessment
  - Community ownership in conjunction with tech support
  - Graywater systems
  - Composting toilets
  - Solar stills
- Graywater project in Tierra Madre, New Mexico uses renewable energy (solar photovoltaics). Graywater is just about any wastewater except that from toilets, which is blackwater.
- Showed micro-treatment system at university in Juarez (Rodrigo Rios).
- Technical assistance for industrial wastewater treatment: bench scale testing, treatability testing, laboratory assistance, training, standardized design, translation, threat assessment.
- Hart-Rudmann report made the point that to have true security, we need to look at economic needs and be addressing them around the world.

Discussion: Key needs

- Local needs assessment must be performed in an integrated manner with technical approaches. Technology is one side. Application of technology is different and requires the social side or will never work without social acceptance.
- Low operating and capital cost (design & materials function)
- Easy and reliable to operate. This includes "knowledge transfer" so that understanding of how to operate and maintain systems is transferred to the community.
- Decentralized systems
- Harmonization of standards (US & Mexican). Note that federal may be different from state regulations, and the first step is to see whether the variation in standards has much impact on what's needed.
- When have blend of funding/needs from both countries, then have a blend of regulatory concerns. This means looking broader than just the Colonias that don't have the centralized treatment because what's being done in the Colonias impacts bigger cities. Adalberto is concentrating on the micro-end and the U.S. EPA is starting at very large macro-end; hoping to meet somewhere in the middle.
- Alternative uses for the desalt concentrate (brine) output or effluent
- Threat assessment for groundwater
- Take creative advantage of local conditions (i.e. temperature, solar) .
- Multiple solutions may be applicable: Reclamation, reuse, and even purification to drinking water standards may all be appropriate in different situations.
- Issue of getting new technologies accepted globally, from funding agencies to manufacturers to communities.
- Necessary to look at integrated solutions for reuse and to store water. In small treatment plants, variability of sewage and flow rates throughout day is not taken into account. This variability requires storage of wastewater. If want to reuse effluent such as for irrigation around homes, would also need storage.
- Reclamation & repurification
- Get understanding of problem and to understand its implications
- Both Federal & State Standards (impact of variation of stds)
- Design of every project should provide a strong socio-economic component of research (like the technical component), so that the project deliverables include the necessary information so that an informed decision can be made about next-phase funding. Project proposals need technical & financial analysis.
- Crux of matter is cost. End-payer is the user. Reality in Mexico and U.S. is that money is becoming tighter. In past, government had financed all infrastructure. CNA does not now have enough money available. US EPA does not have the money. Need to find cost-effective solutions. Financing arena is changing, must tailor proposals and systems to the changing financial environment. More privitization.

Session 5: Arsenic Treatment

Focus: Included cost-effective treatment to reduce arsenic in drinking water

The Mexican perspective was presented by MSc. Carlos Gutiérrez Ojeda (IMTA) and the US by Dr. Larry Bustard (SNL).

Larry Bustard

The talk included a description of the legal framework, arsenic issues in New Mexico, arsenic removal experiences in several places, as well as research work conducted by the American Water Works Association Fundation (20 projects), EPA and SNL.

A binational collaboration proposal was presented that included:

- An expert workshop to identify technologies for potential joint work.
- Enhance border communication.
- Information exchange on the effectiveness of different technologies.

U.S. implementation deadline 2006, European Union 2003; so is European technology more advanced? GFH is European technology.

Carlos Gutierrez Ojeda

The talk focused on arsenic contamination of groundwater in the Laguna Region in the States of Coahuila and Durango in north central Mexico.

- CNA has gone down from 50 ppb to 25ppb. Will implement in steps. Do not have laboratory capabilities to measure low enough.
- Problem is not just arsenic, also have high sodium, chloride, sulfate, fluoride.
- CNA declared most of central part of the Laguna Region as a reserve just for drinking water because it is of the highest quality.
- Incidence of arsenic in the Laguna. Used Carbon-14 data to determine that water containing arsenic is very old, therefore determine that arsenic is naturally occurring from alluvial sediments of volcanic origin.

Topics mentioned during Q&A:

- Point-of-use technology (granular ferric hydroxide)
- Coagulation/filtration for larger communities
- Standards in US from 50 ppb to 10 ppb and in Mexico from 50 ppb to 25 ppb
- Impact on health of lowering standards?
- Should residuals from treatment process be considered hazardous waste?

Discussion: Questions

- Talked about deaths linked to arsenic in drinking water. Clinical observations were high concentrations of arsenic in skin and in hair. Water had 0.5 mg/L (500 ppb) arsenic level. Serious effects are well known at this concentration. But the serious effects – like bladder cancer and lung cancer – are not higher in regions of the U.S.

with higher arsenic. So why go from 50 ppb to 10 ppb? National Research Council determined that, if linear extrapolation and the EPA criteria for risk are both accepted, the data support going to 10 ppb or even lower. But, the types of cancers in question are also linked to smoking. Therefore, cannot discern effects of arsenic in drinking water from other effects. The fact that the World Health Organization set the level to 10 ppb is also a likely factor in the EPA decision.
- Waste issue? California might incur _ - 2/3 of the cost of treatment in waste disposal because of their stringent waste laws.

Discussion: Needs

- Residuals management and disposal
- Cost for both installation and O&M
- Acceptance of new technologies, not only by funding entities but also by regulatory agencies
- Water chemistry decision tool to help decision makers understand how to select treatment technologies that will most economically meet their needs. Utilization of chemical products.
- Alternative sources, such as surface water instead of groundwater, to meet arsenic regulations.
- Laboratory analysis capabilities
- Data collection and dissemination
- Arsenic as an issue has a different priority in Mexico than in the U.S. Culture in Mexico, even amongst very poorest (50 pesos a week salary), is to purchase bottled water. It would be harder to convince them that they could drink the water out of the tap!
- Standards (different need of levels of local priorities; different culture – different solutions)

Specific proposals on the subject of aresenic treatment

1. Share information and establish cooperation mechanisms.
2. Community participation: provide education and training.
3. Work on new technologies.
4. Develop the necessary economic evaluations.
5. Work on several technologies, not just one.
6. Work joint methodologies.

Workshop Conclusion:

The final part of the workshop focused on brainstorming on potential collaborations between the two countries. The results are shown in the following paragraphs:

1. A Web-page to have access to information. The "Host" has yet to be established.
2. SNL will put on its Web-page information regarding the topics of the workshop.

3. A report on the workshop results will be prepared.
4. Several teams were established to work on the following topics:
   - Greenhouses.
   - Treatment and reuse.
   - Field research.
   - Water use and reuse.
5. The technical teams will submit a brief description of their collaboration proposals no later than October 4th.
6. The workshop participants will send additional information on their activities and interest areas to the organizers.

In response to the proposal made during each of the workshop sessions on the availability of information and regarding comments primarily from Mexican universities, in relation to the lack of information from CNA on hydrology, groundwater, and water quality, José María Hinojosa informed on the binational effort to set-up an information sharing system on water quality along the border, with the cooperation of CNA, EPA and IBWC. The news was well received by those in attendance and asked that a brief description on the subject be made available.

Also, SNL agreed to have the different presentations available on its Web-page or, if possible, prepare CD-rom disks to distribute to the workshop participants at a later date.

Next Steps

Overarching Issues

- Data sharing and cooperative processes across border
  - Watersheds know no boundaries
  - Economic health is important to national security in both countries
- Common analysis methodologies
- Get communities invested and provide education and training to them
- Get new technologies accepted by funding entities (public and private) and by regulators
- Binational funding and “map” to negotiate the paperwork maze
- Socio-economic analysis integral to technology development
- Multiple technology paths

Next Steps:

Action Items

- Improve communication and capture of information: an interactive website where people can ask questions and find out what’s going on and where. Something like

BECCnet (link can be found at www.cocef.org). IBWC may be correct host. Wendy and Gray will look into this.

- Info from workshop to be posted on Sandia Water Initiative website and email sent to participants – Jeana and Goldie
- Add information about individuals' interests to attendance list. Can be found in descriptions provided to Heidi. Also ask Heidi for abstracts. – Jeana and Goldie
- Workshop report – Wendy, Jessica, Jorge
- Description of CNA-EPA-IBWC joint database – Jose
- Provide information about BNSL and link to website - Gary
- Technical teams to submit brief descriptions of their collaborative idea to Wendy by 4 October:
  - Greenhouses (Héctor León-Gallegos, Rafael Cabanillas-López, & Gray Lowery)
  - Polymer films for Greenhouses (Darryl Drayer & Héctor León-Gallegos)
  - Solar Stills (Efrén Peña, Rafael Cabanillas & Gray Lowrey)
  - Geophysical survey techniques for salt-water intrusion (Luis Walter Daessle-Heuser & Malcolm Siegel)
  - Water / Wastewater Management & Reuse (Walter Daessle, Bart Christensen, Lorenzo Arriaga, Erik Webb, Leopoldo Mendoza).
  - Gray water (Gray Lowery & Alberto Pombo)
  - Desalt Planning (Belzahet Treviño & Tom Hinkebein) (beyond the roadmap)
  - Efficient water use in agriculture (Belzahet Treviño & Efrén Peña)
- Add info on people's interest to attendance list (BNSL web-site?)